PREBIOTIC PROCESSING OF COMET IMPACT AND SHOCK CHEMISTRY OF ABLATED MATERIALS

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Comets and meteoroids that bombarded the Earth, other planets and moons are considered possible deliverers of prebiotic materials manufactured in space. Simultaneously, chemical processing can be initiated by the large kinetic energy imparted to the planetary atmosphere during comet/meteoroid entry. Our previous study focused on the latter. One important finding in that study was that the production of formaldehyde and the formal radical appears to be independent of the oxidizing/reducing nature of the atmosphere.

Our recent study focuses on glycine ablation during comet impact. Amino acids and other organic compounds important to the chemistry of life are thought to have been delivered to early Earth by comets and meteoroids. The survivability of these compounds upon high-speed entry is not well understood. In our simulation study, the surface of the comet is composed of 95% ice and 5% glycine and the atmospheric composition is 95% N_2 and 5% CH_4. The simulation uses 116 chemical species and 946 chemical reactions. In the example shown below, the initial atmospheric pressure is 0.035 atm, initial temperature 100 K, and impact velocity 10 km/s. The results of the shock chemistry calculations with and without ablation are shown in Fig. 1. In the case with ablation, the ablated material does not retain its chemical identity. Both water and glycine dissociate and react. Our study indicates, not surprisingly, that amino acids do not survive the ablation during entry. They may, however, remain intact if they are deep inside the icy core of the comet.

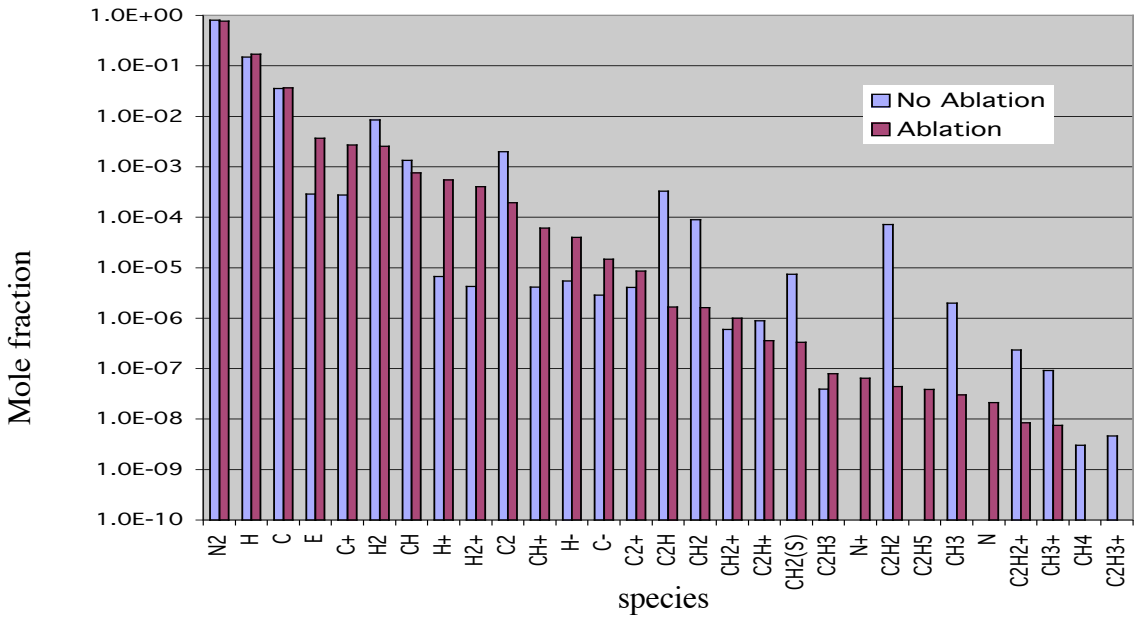

Figure 1. Shock chemistry products of comet impact at 10 km/sec, with and without ablation. The comet is assumed to consist of 95% ice and 5% glycine and the atmosphere is composed of 95% N_2 and 5% CH_4.